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Observations on the nest-building habits of the brush-tailed rat-kangaroo or woylie *(Bettongia penicillata)*

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Abstract

The brush-tailed rat-kangaroo, or woylie (*Bettongia penicillata* Gray 1837), spends the daylight hours in an elaborate well-concealed nest. These nests may be located by radio tracking the animal or by careful systematic searching along transect lines. Nests are located in low dense clumped vegetation types. They are constructed, over shallow depressions dug in the soil, using long strands of material carried as a bundle in the curled-up tail. With the exception of mothers with 'at heel' joeys, the nests are occupied by single animals. Each animal usually has 3 to 4 nests in use at any given time and occupies them in a random fashion. It is speculated that the function of the nest may be avoidance of temperature extremes by the animal.

Introduction

When European man first arrived in Australia, the brush-tailed rat-kangaroo, or woylie, was widespread across the southern portion of the continent. This rabbit-sized kangaroo-like marsupial now inhabits only a few isolated areas of dry sclerophyll woodland in Western Australia (Wakefield 1967, Sampson 1971). Like many Australian mammals it is nocturnal and it spends the daylight hours in an elaborate well-concealed nest (Serventy 1970, Sampson 1971).

With the exception of 2 studies on its biology (Sampson 1971, Christensen 1977), little has been published on the ecology of the woylie and little detailed information is available on its nesting habits. During a study on the fire ecology of this species (Christensen 1977), interesting data, not directly relevant to the study, were accumulated on woylie nests. Although not complete these data provide a useful addition to our knowledge of the biology of this species.

Location of nests

Finding a nest is normally a rare event. Being well-concealed, they are usually found only when an observer comes upon one by chance, flushing the woylie almost underfoot. Radio telemetry has been used successfully to locate nests (Sampson 1971, Christensen 1977). During a study of the biology of the woylie in the Perup forest area, located east of Manjimup (Christensen 1977), a succesful technique consisting of careful searching of all possible hiding places along transect lines was employed to locate nests. This technique was used to obtain data on the relative density of populations of the woylie in different areas. Altogether, along a total of 41 km of transect lines, 221 nests were located in this way. A further 74 nests were found using radio tracking, and several hundred burnt-out nests were located after fires. Burnt-out nests are quite distinctive and clearly visible directly after a fire (Fig. 1).

The nests which were found varied in age from 1 or 2 day-old uncompleted nests to very old collapsed and dilapidated nests several years old and long since vacated by their builders.

Concealment and construction of nests

Woylies in the Perup area live in dry sclerophyll jarrah (*Eucalyptus marginata*) and wandoo (*E. wandoo*) forest. Low flat ridges with an understorey of woody scrub are separated by wide shallow valleys

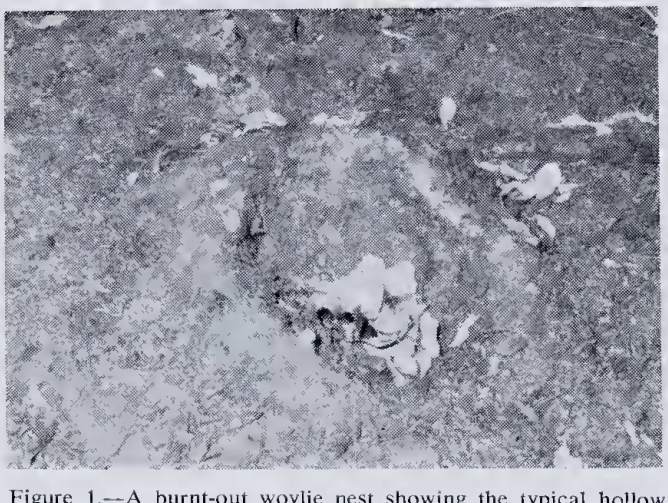

Figure 1.—A burnt-out woylie nest showing the typical hollow surrounded by raised edges on 3 sides. The entrance is facing the camera.

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Figure 2.—An overhanging *Bossiaea ornata* bush held back to reveal a woylie nest. The entrance and part of the roof of the nest can be clearly seen.

and flats generally with a taller more open understorey, and often treeless. Nests are usually found in well-drained areas, on ridges, well concealed under low dense scrub (Fig. 2).

The woylie exhibits distinct preferences in terms of the vegetation communities used for nesting (Table 1). Low, dense, clumped vegetation containing such species as *Bossiaea ornata, Leucopogon capitellatus, Xanthorrhoea gracilis* or *Dryandra armata* is often preferred. Two of the 3 most-preferred scrub communities for nesting, *Hakea lissocarpa/Leucopogon capitellatus* and *Bossiaea ornata,* are also the most common in the area. The third, dense 'grassy' monocotyledons, has a very restricted distribution.

Occasionally nests may be found in other places, such as in or underneath fallen logs, or under newly-fallen leafy branches. However, such sites are normally only used when little else is available, for example on recently burnt ground following a bushfire.

The material from which nests are constructed may vary from one locality to the next, once again depending on availability. In the Perup area jarrah bark stripped from fallen trees or large limbs is preferred. The long narrow leaves of *Persoonia longifolia* may be used on occasions, and nests are often built using grass where this is available. Whatever the material used it must consist of long strands, as the woylie carries it as a bundle in the curled-up tip of its tail (Serventy 1970, Troughton 1967). This remarkable behaviour seems only to have been observed in captive animals. However 7 separate discarded bundles of nesting material made up for transporting in this manner (Fig. 3) have been found in the Perup area. Two bundles were found in traps, the woylie having been captured on its way to its nest with the nesting material in its tail.

Nests are built in shallow depressions from which the earth has been scraped to form a ridge around the rim on 3 sides (Fig. 2). Each nest consists of 2 distinct layers, an exterior layer covering the top and sides, and an inner lining covering the top, sides and floor of the nest.

Observations made on several different nests during radio telemetry studies reveal the sequence of events. First a depression is dug underneath a suitable bush, then a rough outer framework, often of coarse broad strips of jarrah bark, is constructed over the top of the depression. This is then gradually added to, apparently from the inside, until a sufficient thickness is obtained. A soft inner lining of finely shredded jarrah phloem, the inner-most layer of the bark, is added last of all. It appears that it may take up to 2 weeks to finish a nest, although a rough shelter composed of strips of outer bark may be completed in 2 to 3 nights if needs dictate, for example following the destruction of all of an animal's nests during a fire.

Mean measurements and weights of ordinary 'single' nests, and a 'family nest' are shown in Table 2. Nests occupied by a mother and out of pouch juvenile are here referred to as 'family nests'. Family nests are distinguished from single nests largely by their width and the size of the entrance.

Table 1

Distribution of woylie nests by understorey vegetation communities, Perup area

	Vegetation communities sampled in the survey									
	Hakea lissocarpa/ Leucopogon capitellatus	*Bossiaea ornata*	Open wandoo	*Acacia pulchella*	*Hypocalymna angustifolia*	Dry laterite	*Melaleuca viminea*	*Gastrolobium bilobum*	Dense 'grassy' monocotyledons	Granite outcrops
Area searched m^2	131 250	66 132	28 908	52 356	55 080	37 440	10 170	51 534	24 600	17 610
Nests	82	66	1	7	16	...	....	6	17	6
Nests/ha	6·25	5·44	0·35	1·34	2·90	0·00	0·00	1·16	6·91	3·14
% of total nests	22·5	19·6	1·30	4·80	10·4	0·00	0·00	4·20	24·9	12·3

The dominant scrub species are used to indicate the scrub communities sampled in the survey. The communities are arranged in descending order of frequency in terms of the total area covered by each in the Perup area. Three miscellaneous categories are also included:

Open wandoo—low open cover of various scrub species.
Dry laterite—open scrub on infertile soils.
Granite outcrops—dense low cover on shallow sandy soils overlaying granite, typically *Dryandra armata.*

Figure 3.—Bundle of nesting material, consisting of shredded jarrah bark used for inner lining, found discarded in the Perup area.

Oven-dry weights of bundles of nesting material found were as follows: One bundle of outer covering material = 17.5 g; inner lining, mean weight of five bundles = 11.5 g, (range 3.6 — 28.7 g). Woylies must therefore transport from 20 to 25 bundles of outer covering, and 5 to 25 of inner lining in order to make a completed nest. In 4 instances where the source of nesting material was definitely located, it was found to have been obtained from logs located between 20 to 60 m from the nest site. The construction of a nest therefore involves a considerable amount of cartage.

Table 2

Dimensions and weights of woylie nests

	'Single' nest (mean of four nests)	Nest of adult female with juvenile (family nest)
Height	13·5 cm	14 cm
Width	18·9 cm	21 cm
Depth (front to rear)	21·5 cm	21 cm
Height of entrance	7·8 cm	10 cm
Width of entrance	9·0 cm	15 cm
Thickness of nesting materials:		
roof	4·3 cm	2–3 cm
wall	6·0 cm	4 cm
Weight of outer layer	394·7 g	
Weight of inner lining	96·2 g	

All measurements refer to inside dimensions. Weights are oven-dry weights.

Use of the nest

Radio-tracking results obtained by tracking a total of 18 animals (Christensen 1977), reveal that woylies have 3 to 4 separate nests in use, at any one time. Nests are used in a random fashion, one nest rarely being used for more than 2 to 3 consecutive days at a time. Typical data illustrating the use of nests by one individual male followed intermittently over a period of 4 months are given in Figures 4 and 5.

New nests appear to be made at the rate of approximately one per month, at which time one of the old nests is generally abandoned.

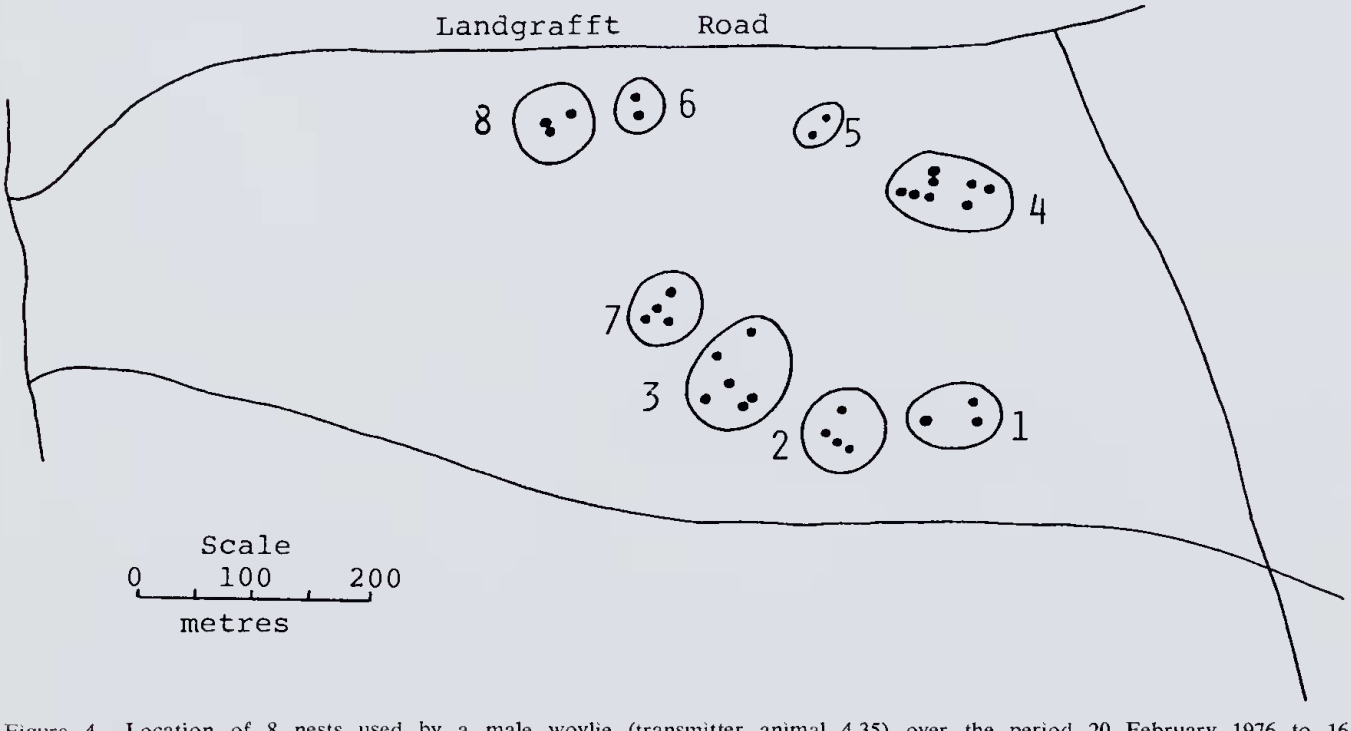

Figure 4.—Location of 8 nests used by a male woylie (transmitter animal 4.35) over the period 20 February 1976 to 16 June 1976. A point on the map represents one radio location of the animal on a particular day. Triangulation errors make it impossible to locate the exact position of the nests (Christensen 1977) which are therefore indicated by clusters of points.

The young out-of-pouch joey remains in the company of its mother, sharing her nest, from the time when it leaves the pouch, at approximately 90 days old, till the next joey vacates the pouch, approximately 100 days later (Christensen 1977). Adult woylies seldom if ever share their nests with other adults. On only 14 occasions out of 88 recorded woylie flushings were 2 animals flushed from the same nest. Nine of these paired flushings were radio-tracked individuals and the pair were known to be a mother with its out-of-pouch joey. In 3 of the remaining double flushings one of the pair was identified as a juvenile by its smaller size.

When flushed, the woylie 'explodes' from its nest almost underfoot. When a mother and joey occupy the same nest, the mother invariably leaves the nest first, to be followed moments later by the joey. The survival value of this was made apparent when in one such instance a dog was present. The dog immediately took off in pursuit of the mother, leaving the slower-moving joey to make good its escape in the opposite direction some moments later.

The woylie spends the daylight hours in its nest. It leaves its nest in search of food at dusk, returning again in the early hours, usually between 0400 and 0500 hours. Animals were located out of the nest during the day only during unusual circumstances, for example, after disturbance by fire, and on 3 separate occasions when juveniles were observed sitting next to cages in which their mothers had been captured. Occasionally woylies may be found still in their nests after dark, but this is rare.

Location of nest sites

Woylies have distinct home ranges within which feeding and nesting areas may be distinguished. Nesting areas are territorial, that of one individual seldom overlapping that of any other individual. Such nesting areas have very specific requirements in relation to scrub density, and are generally situated on ridges. The intervening low-lying areas usually include their feeding range (Christensen 1977). The pattern of nest distribution is well illustrated in the transects described earlier (Fig. 6).

Immediately following fire, nest sites are easy to locate, later rain and weathering soon obscure the small hollows left unprotected by the removal of the nest and scrub cover. Plotting nest sites following fire reveals that they may occur in extraordinary densities on favourable sites (Fig. 7).

The distribution of nest sites appears to be a function of time and scrub density, there being more nests in the 9 year-old scrub because there has been more time for them to accumulate and it is also denser than the 4 year-old scrub. The preference for dense ground cover is further demonstrated by the high density of nests in the area of dense jarrah regrowth by comparison with the other 4 year-old scrub. This requirement of a relatively dense ground cover for nesting has already been demonstrated in a more detailed study (Christensen 1977).

In addition to the cover-density requirement, nest placement appears also to be influenced by the distribution of ground cover. Thus the distribution of nests conforms to a non-random pattern. Groupings of nests observed within randomly located quadrats differ significantly from the expected. The Chi-square test shows that this non-random distribution is more pronounced in the 4 year-old scrub area (signif. 0.001 level) than in the 9 year-old scrub area (signif. 0.05 level).

Prior to the burn, the scrub on the 4 year-old area was patchy, dense areas of *B. ornata* and *H. lissocarpa* being interspersed with areas of sparse vegetation. The 9 year-old scrub comprised a more homogeneous stand of dense *B. ornata*.

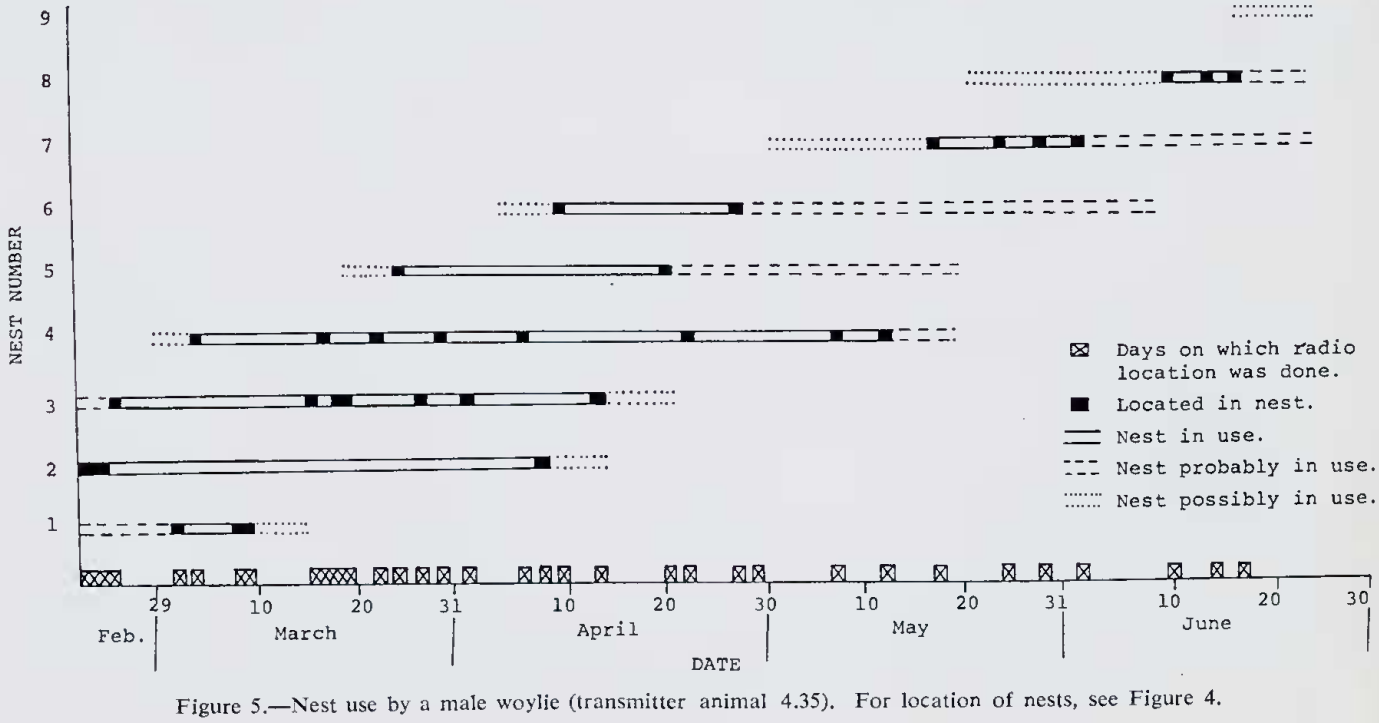

Figure 5.—Nest use by a male woylie (transmitter animal 4.35). For location of nests, see Figure 4.

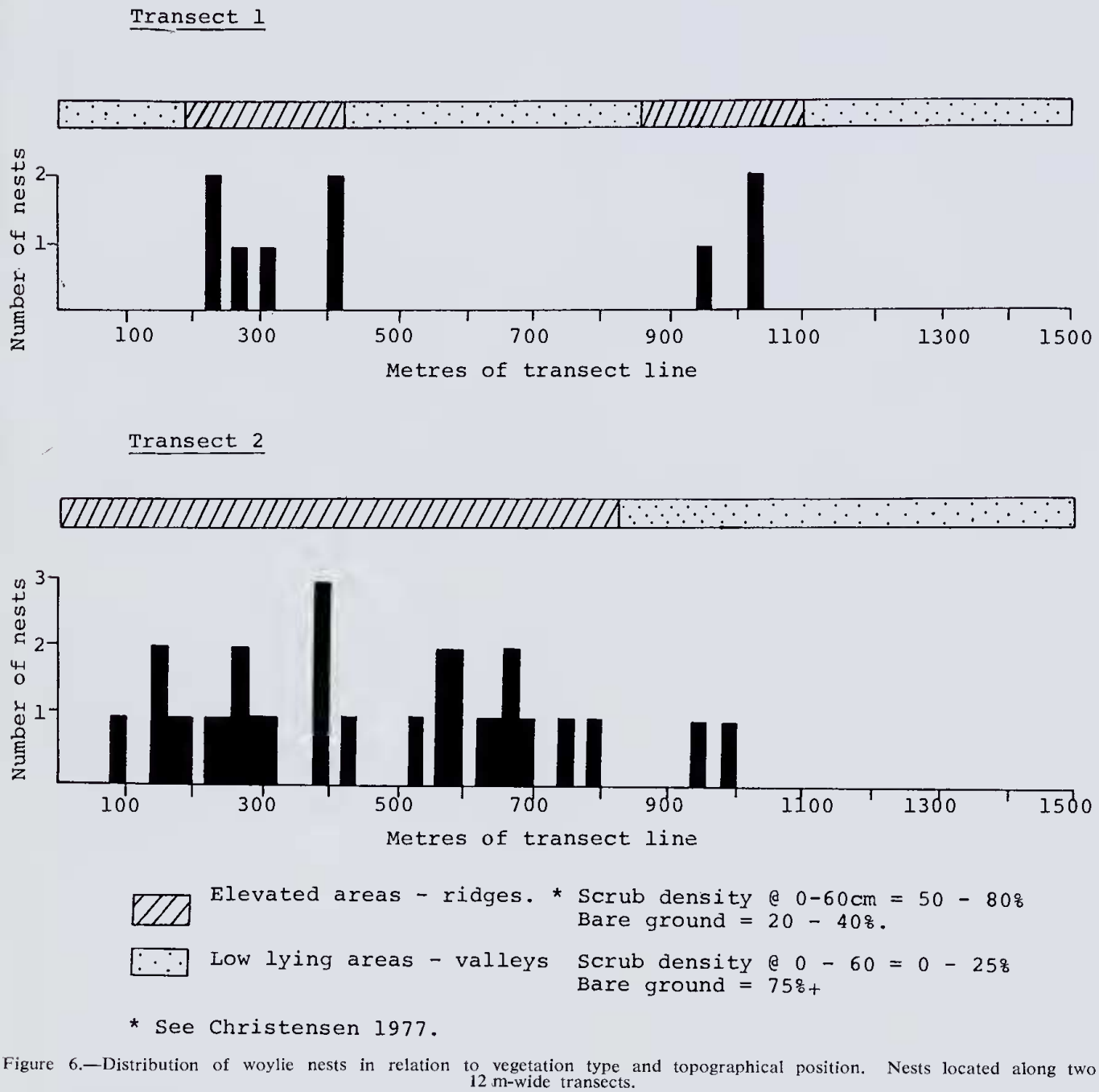

Figure 6.—Distribution of woylie nests in relation to vegetation type and topographical position. Nests located along two 12 m-wide transects.

Significance of the nest

It is not known what role the nest may play in the biology of the woylie.

Most small mammals shelter in nests or burrows during the daytime in order to avoid exposure to extremes of temperatures. The woylie obtains all its water requirements from its food (Sampson 1971). During the summer-autumn months, daytime temperatures are often high, and relative humidity low and body moisture conservation is essential. The very low moisture content of summer scats as compared with winter scats found in traps (personal observation) bear testimony to the efficient water-retention capacity of the animals. Nests may help the animals to further reduce evapo-transpiration levels during periods of excessive heat. Burbidge (pers. comm), has shown measurable differences between nest temperatures, and the ambient air temperature on hot days

The nest may also be important in conserving body temperatures during the colder months when night temperatures often drop below freezing point. Radio-tracking data indicate that woylies usually spend the cold early morning hours within their nests, returning to them long before daylight. During the winter months the woylie is in poor condition (Sampson 1971, Christensen 1977), and this behaviour may assist in the conservation of energy resources which might otherwise be wasted keeping the animal warm.

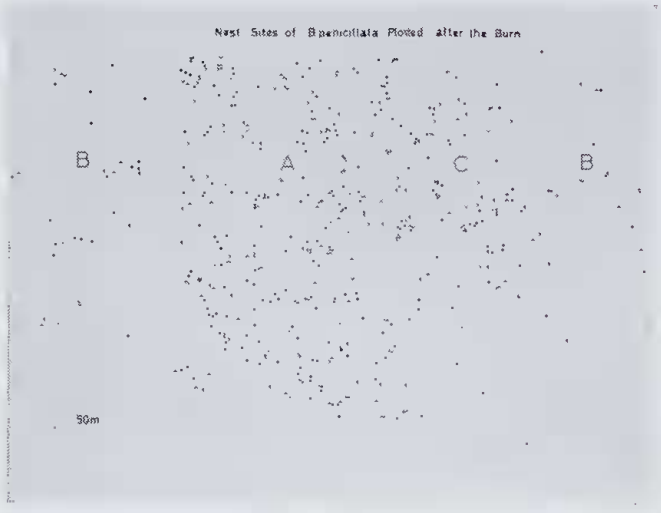

Figure 7.—Map showing distribution of burnt-out woylie nests following a fire in the Perup area. Nests were plotted using a compass and chain. A.—area previously unburnt for 9 years. B.—area previously unburnt for 4 years. C.—area previously unburnt for 4 years with a dense thicket of jarrah regrowth. ///—unburnt area with very sparse vegetation.

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